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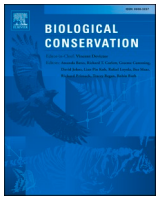

Perspective

Equal use of Indigenous and scientific knowledge in species assessments: A case study from the Northwest Territories, Canada

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ABSTRACT

Interest in meaningfully including and applying Indigenous knowledge in species at risk assessment processes is growing, but serious procedural challenges remain to achieving this in international, national, and regional organizations responsible for assessments. Indigenous knowledge is grounded in place-based, spiritual knowledge and values passed down through generations. This system of knowledge is often misinterpreted, taken out of context, or pushed aside entirely when integrated into processes built for scientific knowledge. Recognizing these challenges, the Species at Risk Committee of the Northwest Territories, Canada, sought to create a process that would permit the meaningful consideration of both Indigenous and scientific knowledge systems in species at risk assessments. This resulted in the development of two sets of complementary assessment criteria with independent components reflecting Indigenous knowledge and scientific knowledge, respectively. The final status assessment is informed by both components, to the extent possible. The Indigenous knowledge criteria also permits a species to be assessed as at risk where Indigenous cultures or traditional ways of life are impeded or rendered impossible because of changes to a species or its habitat. This unique structure permits a more equitable consideration of all sources of best available knowledge and more effectively reflects biocultural linkages. The meaningful consideration of Indigenous knowledge in species at risk assessments is a topic of high importance and we encourage others to re-evaluate the ways in which species at risk assessments are completed.

1. Introduction

Interest in, and acceptance of, the inclusion of Indigenous knowledge in ecological research, monitoring, and assessment processes has increased in recent decades (Berkes et al., 2007; Ziembicki et al., 2013; Cross et al., 2017; Mantyka-Pringle et al., 2017; Ban et al., 2018; McElwee et al., 2020; Peacock et al., 2020). This likely reflects the strongly place-based information that Indigenous knowledge offers, the emphasis on relationships and interconnectedness that are often at the root of many ecological issues (Berkes et al., 2007; Kutz and Tomaselli, 2019), and the increasing acceptance of reconciliation (Kutz and Tomaselli, 2019). Although terminology and definitions vary among sources (Agrawal, 1995; Berkes et al., 2000; Cross et al., 2017; Mantyka-Pringle et al., 2017; Ban et al., 2018), here the term 'Indigenous knowledge' is used to signify place-based and spiritual knowledge and values passed down orally or through experience and built upon through generations of communities (Berkes et al., 2000; GSCI, 2004; SARC, 2020a).

The inclusion of Indigenous knowledge has been discussed in a

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number of key international fora, including the Convention on Biological Diversity (United Nations, 1992), the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (Thaman et al., 2013), and the International Union for the Conservation of Nature (IUCN) (IUCN, 2022a). However, while acceptance is increasing, methods for meaningful inclusion and application of Indigenous knowledge at the decision-making level remain scarce (Brook and McLachlan, 2005; Armitage et al., 2011; Ford et al., 2016; Mantyka-Pringle et al., 2017; Kutz and Tomaselli, 2019). This is the case for species at risk assessments, which globally are often guided by strongly quantitative scientific criteria such as that used for the IUCN Red List for Threatened Species (IUCN Red List Committee, 2013; Tomasini, 2018; IUCN, 2022b; IUCN Standards and Petitions Committee, 2022), or its regional derivations, like what is used by country organizations such as the Committee on the Status of Endangered Wildlife in Canada (COSEWIC; COSEWIC, 2021).

The strongly technical and quantitative focus (e.g., population size based on scientific surveys, trends/fluctuations based on quantitative analysis) of these assessment processes favour scientific knowledge (Ford et al., 2016), often to the exclusion of expertise from Indigenous knowledge systems (Tomasini, 2018). Yet, Indigenous knowledge can improve the breadth and depth of information included in species at risk assessments, reflecting a long-term history of environmental stewardship (Berkes, 1998; Wong, 2016). Although Indigenous knowledge is sometimes 'integrated' into species at risk assessments, and the assessment of species status using both scientific and Indigenous knowledge has been contemplated and encouraged (Cross et al., 2017; IUCN, 2022a), structural changes have not been pursued (Tomasini, 2018). Note that the term 'integrated' is used here cautiously and is representative of the approach of adding Indigenous knowledge, piecemeal, into scientific-western systems.

The limited inclusion of Indigenous knowledge in species at risk assessments may reflect skepticism of conclusions derived from Indigenous knowledge, perceived lower credibility of Indigenous knowledge (Nadasty, 2003; Bonta et al., 2017; Tomasini, 2018; Kutz and Tomaselli, 2019), or difficulties bridging inter-cultural communication (Berkes et al., 2007). Perhaps as a result of these perceptions, the inclusion of Indigenous knowledge appears to be largely limited to anecdotal, corroborating information that is subject to verification by scientists (e.g., Bonta et al., 2017). Differences inherent in Indigenous and scientific knowledge systems have precluded the effective, respectful, and accurate inclusion of Indigenous knowledge in scientific-western systems (Armitage et al., 2011; Thaman et al., 2013; Mantyka-Pringle et al., 2017; Ban et al., 2018). This strongly suggests that a re-examination of the integration paradigm is necessary (Bohensky and Maru, 2011).

In this context, a structural and procedural review of the process for species at risk assessment was completed in the Northwest Territories, Canada, in 2020 by the Species at Risk Committee (SARC). SARC is the body that is responsible for assessing the status of species that may be at risk in the Northwest Territories. The committee sought to create an assessment structure and procedures that would permit the meaningful consideration of both Indigenous and scientific knowledge in species at risk assessments. Here, we present a summary of SARC's species assessment process, the structural revisions made to accommodate Indigenous and scientific knowledge, the outcome of a test assessment, and the results of the first formal species status assessments/reassessments using the revised assessment process.

The authors of this paper include Indigenous community members and researchers from various backgrounds including Shúhtaot'ıné Elder (LA) with the Tulít'a Dene Band in the Sahtú region, Tłı̨chǫ Elder (MR) from Behchokǫ̀ in the Wek'èezhìı region, Gwichya Gwich'in community member and ethnobiologist (AA) from Tsiigehtchic in the Gwich'in region, Inuvialuit member and ecologist (MJG), and non-Indigenous scholars and allies residing in British Columbia (JW), Alberta (NCL), Ontario (AT), and the Northwest Territories (all other authors). The perspectives and development of the objective biological criteria for assessing species in the Northwest Territories relied on first-hand accounts from northern Indigenous and non-Indigenous SARC members as well as published accounts of Indigenous peoples and governments. We recognize that there are many diverse Indigenous worldviews and perspectives that were not captured. We recommend that readers engage with local Indigenous knowledge holders to better understand how the perspectives and context of species assessments can meaningfully include and apply Indigenous knowledge.

2. Regional context

Organizations in northern Canada have made significant strides over the last several decades revising laws, policies, and governance structures to recognize the rights of Indigenous peoples of the region (Berkes et al., 2007; Armitage et al., 2011; Gau et al., 2017; Ostertag et al., 2018). In the Northwest Territories, modern land claim agreements (i.e., agreements setting out Indigenous rights with respect to lands, resources, and self-government) aim to ensure that the meaningful involvement of Indigenous peoples and the consideration of Indigenous knowledge, alongside science, in management and decision-making become increasingly adopted (Berkes et al., 2007; Armitage et al., 2011). A system for the collaborative management of resources has evolved from these agreements and associated legislation, with responsibility for resource management shared among the Government of the Northwest Territories, Tłı̨chǫ Government, Government of Canada, and renewable resources boards established under settled land claim agreements; this arrangement is often referred to simply as 'co-management' (ENR, 2022; Gwich'in Land Claim Settlement Act, 1992; Sahtu Dene and Metis Land Claim Settlement Act, 1994; Tłı̨chǫ Land Claims and Self-Government Act, 2005; Western Arctic (Inuvialuit) Claims Settlement Act, 1984).

In the Northwest Territories, species at risk assessment, conservation, and recovery are guided by the *Species at Risk (NWT) Act*, which was enacted in 2010. The Act includes within its scope all species that are managed at the territorial level. Species that occur on Crown land (e.g., national parks) or that are managed under the legislation of the Government of Canada (e.g., migratory birds under the *Migratory Birds Convention Act*, 1994 and fish under the *Fisheries Act*, 1985) are excluded from the scope of the *Species at Risk (NWT) Act*.

Many aspects of the Northwest Territories' process for species at risk assessment were modelled on processes established and used by the IUCN Red List and by COSEWIC. However, there are several key distinctions in the *Species at Risk (NWT) Act* that reflect the co-management structure noted above and a commitment to meaningful consideration of Indigenous knowledge. In particular, the *Species at Risk (NWT) Act* was developed collaboratively by co-management partners and their legal counsel (Gau et al., 2017). Within the scope of this legislation, these partners work together to build consensus on decisions related to the assessment, listing, conservation, and recovery of species at risk, and each participate in the implementation of these decisions. Insofar as species at risk assessments are concerned, the *Species at Risk (NWT) Act* requires the inclusion of all best available information (i.e., information from Indigenous and scientific knowledge on the status, threats, and positive influences on a species, with positive influences referring to, for example, population increases, habitat restoration or conservation efforts).

As noted previously, species at risk assessments in the Northwest Territories are completed by SARC. The members of SARC are experts on species and ecosystems within the region and their expertise can be drawn from either or both knowledge systems. Membership is shared relatively evenly between Indigenous knowledge and scientific knowledge holders (NWT Species at Risk, 2022). Members are appointed to SARC by the Government of the Northwest Territories, Tłı̨chǫ Government, Wildlife Management Advisory Council (NWT), Gwich'in Renewable Resources Board, Sahtú Renewable Resources Board, Wek'èezhìı Renewable Resources Board, and the Government of

Canada. Appointments are considered by all of the above-noted co-management authorities to ensure that SARC membership has representation across knowledge systems and regions, as well as an adequate scope of expertise to conduct species assessments. SARC responsibilities may form part of some members' regular jobs, while others may serve in their personal time. Where personal time is being used, members are compensated for their time. If membership is part of an individual's regular job, SARC decisions must be completed independent of the interests of their appointing organization. Members cannot consider potential socio-economic implications of their assessments. Meetings are thus closed to casual observers to facilitate these objectives. Assessment decisions must be based on a consensus among all SARC members. Members are appointed for a period up to five years and members may be reappointed for one or more terms.

Species status reports are prepared by outside experts to help inform species at risk assessments. These reports are typically prepared in two parts, including an Indigenous knowledge component and a scientific knowledge component. Each component represents a consolidation of best available information within the scope of each knowledge system. SARC does not have a mandate for primary research; thus, 'best available information' consists of information already gathered and publicly available. The preparation of each status report component is guided by instructions tailored to the knowledge system; information is summarized side-by-side in the executive summary of the final species status report to facilitate access to key assessment information (Species at Risk Committee, 2020a, b).

3. Assessment process

3.1. Initial assessment process and its shortcomings

From 2010 to 2020, the initial iterations of the species at risk assessment process in the Northwest Territories were modelled on the processes established by the IUCN Red List (IUCN Standards and Petitions Committee, 2022) and COSEWIC (COSEWIC, 2021). This included the original quantitatively defined assessment criteria framework, modified to integrate Indigenous knowledge into it. However, this 'integrated' version left practitioners of both knowledge systems unsatisfied. Indigenous knowledge holders on SARC remained unable to participate fully or comfortably in the process because the retained scientific-western framework led to highly technical discussions. The removal of quantitative definitions from the assessment process left members familiar with the original processes feeling vulnerable to criticism and without adequate tools to quantifiably substantiate species status assessments.

3.2. Inclusion of Indigenous knowledge

In 2020, SARC agreed the process needed fundamental changes to ensure both knowledge systems could operate effectively and in accordance with their practices and standards, while continuing to facilitate the consistent and credible assessment of probability of species extinction in the Northwest Territories, the identification and prioritization of species at high risk of extinction, differentiation among levels of risk (i.e., extinct, extirpated, endangered, threatened, special concern, not at risk; see Table 1 for definitions), and determination of information adequacy (i.e., data deficiency).

The revised species assessment process builds upon the work of McNeely and Hunka (2011) in their critique of the Canadian *Species at Risk Act*. The process establishes a system of dual (side-by-side) species assessments: one based on Indigenous knowledge and the other based on scientific knowledge. Each knowledge-specific assessment is informed by that respective component of the status report (i.e., the Indigenous knowledge component or scientific knowledge component of the status report). This structure helps ensure each knowledge system's autonomy, uniqueness, and validity are represented and respected (Brook and

Table 1
Objective biological criteria for both Indigenous and scientific knowledge used in the assessment of species that may be at risk in the Northwest Territories, Canada.

Indigenous knowledge (ICK)	Scientific knowledge (SK)
Extinct – The species[1] no longer exists anywhere in the world.	
ICK(a): There is enough information to know that *no individuals* of the species remain alive in the *world* **OR** ICK(b): There is enough information to know that there is *no remaining habitat* for the species anywhere in the *world* **AND** there have been *no recent observations* of individuals of the species.	SK(a): There exists no remaining habitat for the species in the *world* **AND** there have been no records of the species despite recent surveys **OR** SK(b): 50 years have passed since the last credible record of the species in the *world*, despite surveys in the interim **OR** SK(c): There is sufficient information to document that no individuals of the species remain alive in the *world*.
Extirpated – The species no longer exists in the wild in the NWT but it does exist in the wild outside the NWT.	
ICK(a): There is enough information to know that *no individuals* of the species remain alive in the *NWT* **OR** ICK(b): There is enough information to know that there is *no remaining habitat* for the species anywhere in the *NWT* **AND** there have been *no recent observations* of individuals of the species.	SK(a): There exists no remaining habitat for the species in the *NWT* **AND** there have been no records of the species despite recent surveys **OR** SK(b): 50 years have passed since the last credible record of the species in the *NWT*, despite surveys in the interim **OR** SK(c): There is sufficient information to document that no individuals of the species remain alive in the NWT.
Endangered – The species is facing imminent extirpation from the NWT or extinction.	
ICK(a): Knowledge holders have observed such *important and widespread declines* in abundance[2], habitat quality/quantity, movements, or range that *significant adverse impacts* to Indigenous cultures and traditional ways of life tied to the species or its habitat have advanced to a point that *continued cultural connection to the species has been made impossible or is extremely impaired* **OR** ICK(b): It is *generally agreed* that the species is observed *far less frequently* than in the past in a large portion of its range, such that it is a topic of *frequent conversation*[3] *and high concern* **AND** there is little indication that the species has simply moved elsewhere **OR** ICK(c): It is *generally agreed* that the species is observed *less frequently* than in the past in a large portion of its range **AND** is understood by knowledge holders to be *very sensitive* to natural or human-caused threats **AND** knowledge holders express *high* concern about *widespread threats* impacting the species **OR** ICK(d): It is *generally agreed* that the species' overall range has *contracted substantially*, such that the species is *not observed, or is largely not observed*, in areas where it was historically present, in a manner that is outside normal patterns **AND** there is little indication that the species has simply moved elsewhere **OR** ICK(e): There is concern expressed by knowledge holders that the species is *likely to disappear* from the NWT within their grandchildren's lifetimes.	*See Supplementary Material, Table A1.
Threatened – The species is likely to become Endangered in the NWT if nothing is done to reverse the factors leading to its extirpation or extinction.	
ICK(a): Knowledge holders have observed *enough declines* in abundance, habitat quality/quantity, movements, or range use that *adverse impacts* to Indigenous cultures and traditional ways of life tied to the species or its habitat *are*	* See Supplementary Material, Table A1.

(*continued on next page*)

Table 1 (*continued*)

Indigenous knowledge (ICK)	Scientific knowledge (SK)
underway in most of the range **OR** ICK(b): There are *increasing reports* that the species is observed *less frequently* than in the past in a large portion of its range, such that it is an *increasingly common topic of conversation* and a *moderate concern* **AND** there is little indication that the species has simply moved elsewhere **OR** ICK(c): There are *increasing reports* that the species is observed *less frequently* than in the past in a large portion of its range **AND** is understood by knowledge holders to be *somewhat sensitive* to natural or human-caused threats **AND** knowledge holders *often* express concern about threats impacting the species **OR** ICK(d): There are *increasing reports* that the species' range is *contracting noticeably*, such that it is *increasingly difficult* to observe in areas where it was historically present, in a manner that is outside normal patterns **AND** there is little indication that the species has simply moved elsewhere **OR** ICK(e): There is concern expressed by knowledge holders that the species is *likely to experience severe declines* in the NWT, in its abundance, habitat quality/quantity, movements, and/or range, within their grandchildren's lifetimes.	
Special Concern – A species that may become Threatened or Endangered in the NWT because of a combination of biological characteristics and identified threats.	
ICK(a): Knowledge holders are observing *changes* in abundance, habitat quality/quantity, movements, or range, but these changes are *not yet large enough to qualify the species for Threatened* **AND** knowledge holders express concern that the species is being *adversely impacted* by one or more natural or human-caused threats **OR** ICK(b): The species displays *characteristics* that are likely to negatively affect its response to decline **AND** knowledge holders express concern that the species is being *adversely impacted* by one or more natural or human-caused threats that could cause the species to become Threatened if *not effectively addressed and management* **OR** ICK(c): The species almost qualifies for Threatened status, under any criterion.	SK(a): The species has declined to a level of abundance at which its *persistence is increasingly threatened* by genetic, demographic, or environmental stochasticity, but the decline is *not sufficient to qualify the species as Threatened* **OR** SK(b): The species *may become Threatened* if factors suspected of negatively influencing the persistence of the species are *neither reversed nor managed* with demonstrable effectiveness **OR** SK(c): The species is *near to qualifying*, under any criterion, for Threatened status **OR** SK(d): The species qualifies for Threatened status but there is *clear indication of rescue effect* from extra-limital subpopulations.
Data Deficient – A species in respect of which SARC does not have sufficient information to categorize as Extinct, Extirpated, Endangered, Threatened, Special Concern, or Not at Risk.	
Not at Risk – A species that has been evaluated and found to be not at risk of extinction given the current circumstances.	

McLachlan, 2005; McNeely and Hunka, 2011).

To build this system, SARC constructed a set of new Indigenous knowledge criteria (Table 1) that reflect recommendations made by Indigenous knowledge holders, practitioners, status report preparers, and reviewers received from 2010 to 2020. The criteria reflect observations of change by knowledge holders, including changes in abundance, habitat quality/quantity, movements, range, and exposure to threats (Fig. 1). 'Measurement' of change in this context considers direct observation of species/habitat by knowledge holders, as well as proxies of parameters such as abundance (e.g., accessibility, harvest success). Scaling of threat categories (e.g., endangered versus threatened) reflects level of concern among knowledge holders. The new Indigenous knowledge criteria also recognize biocultural connections as defined in article 8(j) of the Convention on Biological Diversity (United Nations, 1992); that is, a species can be assessed as at risk if Indigenous cultures or traditional ways of life related to that species are impeded or rendered impossible because of changes to the species or its habitat.

Meanwhile, SARC also returned the scientific criteria to a structure fully based on the processes of the IUCN Red List and COSEWIC but scaled to a regional level (see Supplementary Material 1, Tables A1 and A2).

3.3. Dual assessment process application and test case

When a species is assessed, all SARC members, regardless of the knowledge system from which their expertise is derived, attend and participate in both components of the dual assessment process. Although Indigenous knowledge holders lead the Indigenous knowledge assessment and scientists lead the scientific knowledge assessment, questions and discussion are encouraged to ensure comprehension across knowledge systems. This facilitates cross-cultural communication and learning and ensures the final status assessment is based on the best available information. From these two knowledge-specific assessments, SARC arrives at a final assessment recommendation (i.e., extinct, extirpated, endangered, threatened, special concern, data deficient, or not at risk) based on a consensus among members, and supported by criteria from either or both knowledge systems. The assessment, along with uncertainties and any important differences between knowledge systems, are described in an assessment summary. If information is available from only one knowledge system, then the assessment is completed using the criteria from only that knowledge system.

Revisions to the species assessment process were tried and refined by SARC in a test assessment of northern mountain caribou (*Rangifer tarandus caribou*) in August 2020 (Fig. 2). Northern mountain caribou had been formally assessed recently (April 2020 using an earlier iteration of the assessment criteria [Species at Risk Committee, 2020c]); this ensured the status report was reasonably up-to-date and members were still familiar with its details. The test assessment was completed, procedurally, in the manner of a true assessment (i.e., assessing supporting evidence for each assessment category and its associated criteria). Supporting evidence from the Indigenous knowledge component of the status report was used to determine status using the Indigenous knowledge criteria and supporting evidence from the scientific knowledge component of the status report was used to determine status using the scientific knowledge criteria. Following the completion of each knowledge-specific assessment, members arrived at a single consensus-based (test) assessment recommendation. The result – a status of Special Concern – was consistent with the assessment result derived using the earlier assessment process and criteria (Species at Risk Committee, 2020c). Throughout the test, members discussed the performance of the revised assessment process to evaluate whether each criterion made sense, whether the criteria worked well together, and whether the revised criteria properly reflected species status information. The test assessment process and outcomes directed final revisions to the criteria to ensure they met the intent (building upon previous legal and policy work) and conditions (effective and meaningful consideration of both Indigenous and scientific knowledge) envisioned by SARC.

The revised assessment process and criteria were finalized and approved by SARC in October 2020 (Species at Risk Committee, 2020d; Fig. 3).

4. Application of the revised assessment process and criteria

4.1. Formal case application

The first formal application of the new dual assessment process and criteria took place in April 2021 for the reassessment of polar bear (*Ursus maritimus*) in the Northwest Territories (SARC, 2021). Using both the

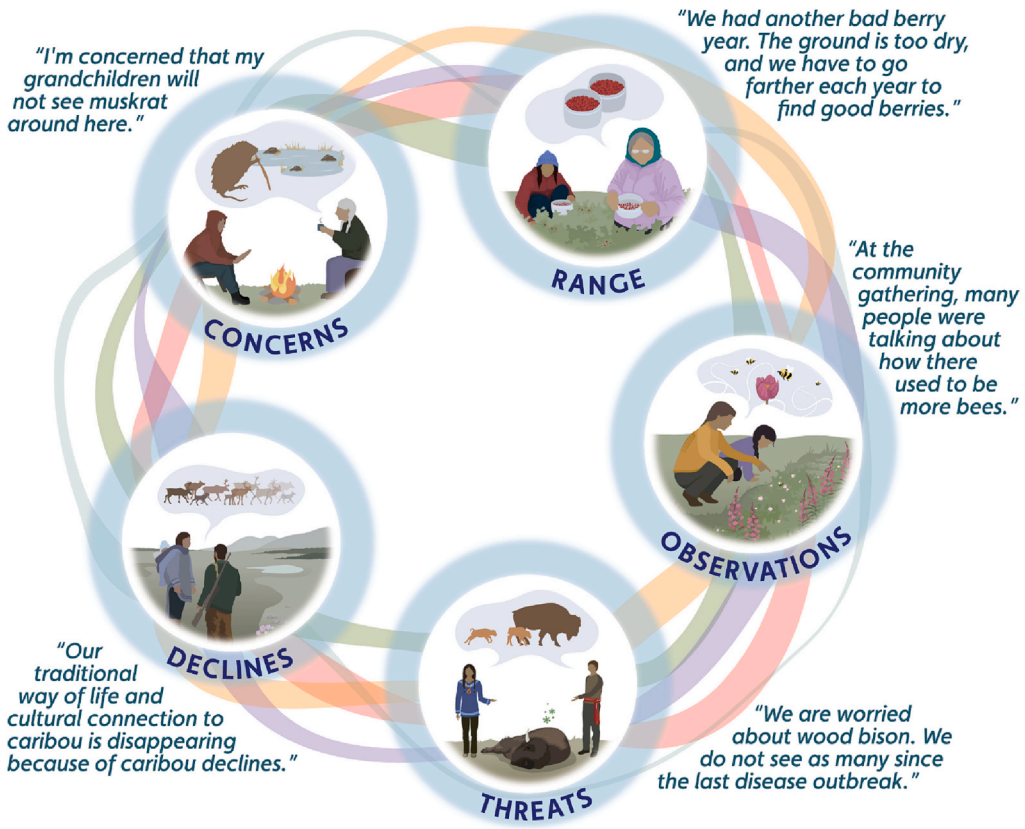
"I'm concerned that my grandchildren will not see muskrat around here."
CONCERNS
"We had another bad berry year. The ground is too dry, and we have to go farther each year to find good berries."
RANGE
"At the community gathering, many people were talking about how there used to be more bees."
OBSERVATIONS
"We are worried about wood bison. We do not see as many since the last disease outbreak."
THREATS
"Our traditional way of life and cultural connection to caribou is disappearing because of caribou declines."
DECLINES

Fig. 1. Dene, Métis, and Inuit (i.e., Indigenous) interpretation of the Indigenous knowledge criteria used in species status assessments in the Northwest Territories, Canada. The examples and quotations presented are intended for illustrative and educational purposes only. They do not represent the words of any actual person. In the case of disagreement between these images and the Species Assessment Process (Species at Risk Committee, 2020d), the Species Assessment Process prevails.

Indigenous and scientific knowledge criteria (supported by evidence from each status report component), SARC determined that polar bear is a species of Special Concern in the Northwest Territories (SARC, 2021; Table 2).

The Indigenous knowledge component of the status report described changes in range, movements, and habitat, but no important changes in abundance since the status assessment in 2012 (Species at Risk Committee, 2012). Declines in the physical size of animals and signs of nutritional stress were noted, and some knowledge holders suggested animals may be shifting their ranges further north and further out onto multi-year sea ice. Movements of individuals between areas appeared to be continuing relatively uninhibited, but concern was expressed that polar bears were being adversely impacted by one or more natural or human-caused threats. Knowledge holders suggested that climate change may eventually result in changes to denning habitat, habitat suitability, health, and prey availability given the strong relationship between polar bears and sea ice. Knowledge holders also reported strong variability of ice conditions between years and regions, and declines in multi-year sea ice. Although this was concerning, greater hunting opportunity provided to polar bears by annual versus multi-year sea ice was thought to benefit the species in some areas. Polar bears were recognized as being intelligent and adaptable by knowledge holders, suggesting they may be somewhat resilient to habitat changes. The Indigenous knowledge assessment fit criterion ICK(a) for Special Concern indicating that knowledge holders were observing changes in abundance, habitat quality/quantity, movements, or range, but these changes were not yet large enough to qualify polar bear for an assessment of Threatened (SARC, 2021).

The scientific knowledge component of the status report described declines in the condition of seals (a key prey species for polar bears), declines in the extent and thickness of sea ice, and potential future increases in development in the region as threats to polar bears. However, without updated research and survey information, the importance of these forces to polar bears remained uncertain. Rescue from neighbouring subpopulations was considered a possibility for at least some subpopulations. The scientific knowledge assessment fit criterion SK(b) for Special Concern indicating that polar bear may become Threatened if factors suspected of negatively influencing the persistence of the species are neither reversed nor managed with demonstrable effectiveness (SARC, 2021).

SARC members, in discussion following completion of the formal status assessment for polar bear, agreed that the knowledge-specific criteria were beneficial and easy to use in practice. In particular, Indigenous knowledge members felt they were able to participate in a meaningful way, while scientists were able to contribute in accordance with accepted scientific standards and practices. Overall, the two knowledge systems complemented one another, and members were pleased with the process and outcome.

Subsequent formal reassessments of Peary caribou (*Rangifer tarandus pearyi*) and boreal caribou (*Rangifer tarandus caribou*) and a formal assessment of peregrine falcon *anatum/tundrius* complex (*Falco peregrinus*) were completed in May 2022 using the new dual process and criteria. The reassessments of the two caribou used both Indigenous and scientific knowledge and criteria, whereas the assessment of peregrine falcon used only the scientific knowledge criteria as there was not a sufficient amount of available Indigenous knowledge for assessment.

Peary caribou were reassessed as Threatened (consistent with the status assessment in 2012), reflecting concerns with its recovery from population declines in the 1960s–90s and vulnerability to stochastic events and climatic changes within its range (SARC, 2022a). Boreal caribou were also reassessed as Threatened (consistent with the status assessment in 2012). The status is indicative of continued sensitivity to

Fig. 2. (a) Northern mountain caribou (*Rangifer tarandus caribou*) in the Mackenzie Mountains of the Yukon and Northwest Territories, Canada and (b) sharing the harvest.
Photo credit: Norman Barichello (top) and Josh Barichello (bottom), used with permission.

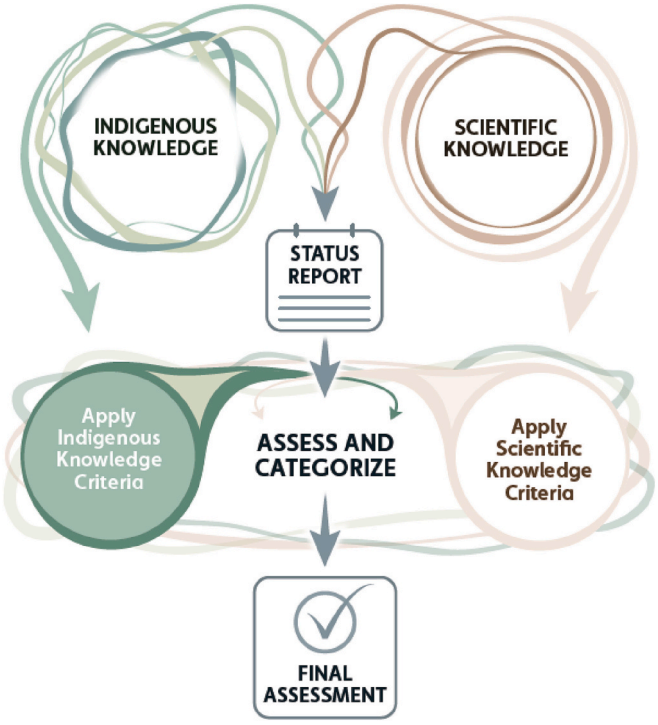

Fig. 3. Overview of the species assessment process in the Northwest Territories, Canada.

habitat fragmentation from both anthropogenic (e.g., resource development) and natural causes (i.e., wildfires) (SARC, 2022b). Peregrine falcon were assessed as Not at Risk in the Northwest Territories due to their stable population in the region, proven resiliency, and the presence of few major threats (SARC, 2022c).

4.2. Addressing conflicts between knowledge systems

Differences in information and interpretation will, of course, arise (Ban et al., 2018; Kutz and Tomaselli, 2019). This is to be expected when comparing information gathered using different methods, and often operating at different temporal and spatial scales (Bohensky and Maru, 2011). This is not unique to work done across knowledge systems; differences often occur even within a single knowledge system. Disagreement between knowledge systems did not arise during the reassessments of polar bear or boreal caribou (and was not a factor in the assessment of peregrine falcon). However, resolution of differences was necessary during the formal reassessment of Peary caribou. Using the Indigenous knowledge criteria, Peary caribou were reassessed as Threatened under criterion ICK(e), reflecting concerns from Indigenous knowledge holders about adverse impacts to Indigenous ways of life as a result of scarcity in some portions of the range and vulnerability of the species to further declines given numerous threats, which were expected to increase in the future (e.g., extreme weather, changing sea ice conditions, marine traffic, predation, and competition for food). In contrast, using the scientific knowledge criteria, Peary caribou were reassessed as Special Concern under criteria SK(a) and (b), reflecting recent increases in the population but low genetic diversity and continuing threats (e.g., climate change, grizzly bear range expansion, industrial development, and marine traffic). In reconciling these contrasting outcomes, SARC agreed that a precautionary approach was warranted and determined that an overall assessment of Threatened for Peary caribou was appropriate (SARC, 2022a).

The revisions to the species status assessment process presented here do not suggest a method for preventing these differences; rather, regular meetings between members who represent a balance of worldviews and who are committed to working together to build trust and respect (Berkes et al., 2007) provide an avenue for examining and working through disagreements collaboratively, and formally documenting remaining differences.

Table 2
Outcome of the species status assessment for polar bear (*Ursus maritimus*) in the Northwest Territories, Canada, using the revised objective biological criteria (summarized from SARC, 2021).

Assessment: Special Concern in the Northwest Territories **Definition**: May become Threatened or Endangered in the Northwest Territories because of a combination of biological characteristics and identified threats	
Supporting criteria — Indigenous knowledge	**Supporting criteria** — Scientific knowledge
Special Concern(a) – Knowledge holders are observing changes in abundance, habitat quality/quantity, movements, or range, but these changes are not yet large enough to qualify the species for Threatened AND knowledge holders express concern that the species is being adversely impacted by one or more natural or human-caused threats.	*Special Concern(b)* – The species may become Threatened if factors suspected of negatively influencing the persistence of the species are neither reversed nor managed with demonstrable effectiveness.
Rationale: Polar bears are solitary animals living at very low densities, undertaking long-distance movements in search of suitable habitat conditions and prey, and with large home ranges. Declines in body size and signs of nutritional stress have been observed by knowledge holders. The effects of climate change are clearly noticeable in the region and in the future may affect denning habitat, habitat suitability, animal health, and prey availability. Declines in multi-year sea ice are being observed as well. A shift in distribution further north and further out onto multi-year sea ice may be occurring, along with increased frequency of excursions onto mainland. Cumulative effects from increases in arctic development and climate change are a concern. However, declines in abundance have not yet been reported. Knowledge holders also recognize that polar bears are highly intelligent and adaptable species. A shift from multi-year to annual sea ice may benefit some polar bear subpopulations in the future.	**Rationale**: Updated survey results were not available for this re-assessment, impeding an assessment of abundance or population trends. Continuing declines in ice thickness and summer sea ice extent have been reported since the 1970s. Most models project ice-free summers in the Arctic Ocean by mid-century. These declines are of most concern for the Southern Beaufort Sea subpopulation, given associated declines in survival and reproduction reported from the Alaskan portion of its range. Changing ice conditions have also been linked to declining condition in seals, a key prey species for polar bears.

5. Benefits and limitations of the revised assessment process and objective biological criteria

Changing the species at risk assessment structure to a dual system as described above aims to minimize the extractive and corroborative uses of Indigenous knowledge and avoid it being 'integrated' into an existing framework (Nadasdy, 1999, 2003; Berkes et al., 2007; Bohensky and Maru, 2011; Tomasini, 2018), instead ensuring that all sources of best available information are considered throughout the assessment process.

SARC's dual approach brings the Northwest Territories more in line with the goals of the United Nations Declaration on the Rights of Indigenous Peoples (i.e., rights of Indigenous peoples to their knowledge and the contribution of this knowledge to environmental management; United Nations General Assembly, 2007) and article 8(j) of the Convention on Biological Diversity (United Nations, 1992). The assumption implicit in this approach is that Indigenous knowledge and scientific knowledge, together, can be used to effectively assess the status of species.

In this context, the 'verification' of Indigenous knowledge in a

manner acceptable to scientists is not considered necessary; in fact, we would argue that the acceptance of Indigenous knowledge as a system of knowing in its own right effectively precludes the acceptability of any a priori verification of one knowledge system by another (Agrawal, 1995; Tomasini, 2018).

The work presented in this paper represents a modification of a structure derived from western science and therefore, may not yet fully accomplish the balanced and respectful inclusion of both knowledge systems (Nadasdy, 1999; Berkes et al., 2000, 2007). Limitations to its implementation are recognized, including a structure still focused on single-species assessments (although the *Species at Risk (NWT) Act*, 2009 does allow for multi-species and ecosystem assessments, these tools have not been used to date); a threat assessment/ranking structure that, while modified from that used by the IUCN to increase its accessibility (IUCN, 2022c), still represents a scientific-western bias in thinking; uneven allocation of research funds; the treatment of people as a force impacting species but not having a relationship with species, and a tendency for documented Indigenous knowledge to be removed from the cultural, spiritual, linguistic, and ecological context integral to its accurate interpretation (Berkes et al., 2000; Polfus et al., 2017; McElwee et al., 2020; SARC, 2020e). It is also important to note that the revisions SARC undertook may not be equally applicable in all regions or at all jurisdictional levels. SARC's ability to undertake this work reflects a governance context defined by land claim agreements, co-management of natural resources, cooperative legislative development, and mandated consideration of both Indigenous and scientific knowledge. This context is likely to differ among jurisdictions. However, this work does represent an important step forward in equalizing the power dynamics at the assessment table and moving away from the structural favouring of science.

6. Conclusion

The revised species assessment process outlined in this paper aims to draw on the strengths of Indigenous knowledge and scientific knowledge (Ban et al., 2018) while avoiding integration of one into the framework of the other. The consideration of both knowledge systems permits a deeper level of understanding of species status than would be possible with only one source of knowledge (Cross et al., 2017; Mantyka-Pringle et al., 2017; Kutz and Tomaselli, 2019), thus strengthening the species at risk assessment process (Brook and McLachlin, 2005) and potentially increasing public trust in the outcomes. The inclusion of a criterion reflecting the link between species and cultural declines, represents, to the best of our knowledge, a novel approach to species at risk assessment. Structural revisions of this nature may also help prevent the loss of generational knowledge important to Indigenous peoples and biodiversity conservation (Ziembicki et al., 2013).

This work is a step towards building dialogue among knowledge holders of different disciplines and balancing power between them (Agrawal, 1995). Our intention in sharing these revisions is not to devalue the contributions of science to biodiversity conservation or species at risk assessment. Rather, our intent is to build upon legal and policy developments in the Northwest Territories, and international commitments and recommendations related to the inclusion of Indigenous knowledge, to create a structure that permits the effective and meaningful consideration of both Indigenous and scientific knowledge in species at risk assessments.

We recognize that this approach to species status assessment deviates from the criteria used by the IUCN Red List and may be regarded as inconsistent with the universal use of one single set of criteria at regional scales to allow comparability among jurisdictions (IUCN Red List Committee, 2013). We are encouraged by the efforts of the IUCN Red List and national organizations (e.g., COSEWIC in Canada) who continuously aim to strengthen the ways in which Indigenous knowledge could be effectively and meaningfully included in species at risk assessments. We welcome a close examination of our Indigenous knowledge-based criteria, and we look forward to comments and changes that further reflect emerging best practice described in international agreements, land claim agreements, conservation legislation, and policy.

CRediT authorship contribution statement

Claire L. Singer: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing, Supervision, Project administration. **Mélanie R. Routh:** Writing – original draft, Writing – review & editing, Supervision. **Michele J. Grabke:** Writing – review & editing, Supervision, Project administration. **Leon Andrew:** Methodology, Validation, Writing – review & editing. **Suzanne Carrière:** Methodology, Validation, Writing – review & editing. **Aimee Guile:** Methodology, Validation, Writing – review & editing. **Alestine Andre:** Methodology, Validation, Writing – review & editing. **Allison Thompson:** Methodology, Validation, Writing – review & editing. **Deborah Simmons:** Methodology, Validation, Writing – review & editing. **Kaytlin Cooper:** Methodology, Validation, Writing – review & editing. **Lynda Yonge:** Methodology, Validation, Writing – review & editing. **Moise Rabesca:** Methodology, Validation, Writing – review & editing. **Nicholas C. Larter:** Methodology, Validation, Writing – review & editing. **Petter Jacobsen:** Methodology, Validation, Writing – review & editing. **Rosemin Nathoo:** Methodology, Validation, Writing – review & editing. **Janet Winbourne:** Methodology, Validation, Writing – review & editing. **Adam Bathe:** Methodology, Validation, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.biocon.2023.109995.

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